

SPORTS

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Electromotive Drive, especially for the Pump of a Power-Assisted Steering System of a Motor Vehicle.

The invention relates to an electromotive drive, especially for the pump of a power-assisted steering system of a motor vehicle with the characteristics of the preamble of Patent Claim 1.

As a rule, electromotive pumps are employed with power-assisted steering systems, whereby the engines are designed in such manner that these are operated at full load for only a brief period of time. In particular, when known engines and/or pumps for the hydraulics of the power-assisted steering system designed as an integral part of the former are operated at full load, disturbing whistling noises are generated which, obviously, are attributable to relatively high-frequency torque variations.

Known electromotive drives and/or electromotive pumps have an electric motor, which comprises a stator and a rotor, with the latter being realized as external rotor which encompasses the stator.

The stator is positioned on a bearing journal which extends through the stator and is firmly connected with same. In addition, for transmission of the torque from the stator to the remaining housing, an axial split pin is installed between stator and bearing journal, in opposite recesses in the interior wall of the stator and the exterior wall of the bearing journal. At the underside of the stator, the connecting contacts of the stator windings are joined with a plate arranged between stator and housing bottom, on which is provided the control electronics for the engine or the pump.

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Proceeding from said state of the art, it is the object of the invention to create an electromotive drive, especially for the pump of a power-assisted steering system of a motor vehicle, for which the disturbing noises occurring with known drives are largely prevented, at least, however, are drastically reduced.

The invention solves said object with the characteristics of Claim 1.

The invention proceeds from the recognition that the disturbing noises are presumably created by the substantially rigidly coupled stator/bearing journal system, which generates a 'tuning fork' effect when the resonant frequency of the system falls in the range of the unavoidable high-frequency torque variations, which are practically unavoidable with electric motors and which, primarily with full load, have sufficient amplitude to lead to the disturbing noises.

According to the invention, with respect to the torque transmission, the rigid coupling between stator and bearing journal is eliminated. The transmission of the torque moment substantially occurs only via the coupling of the stator with the remaining housing (disregarding the bearing journal). The bearing journal serves only for mounting the stator in the plane which extends in transverse direction vis-a-vis the axis of the bearing journal. In actual practice, elimination of the split pin (or similar coupling means) causing the rigid coupling has resulted in a clear reduction of the disturbing noises.

An improved suppression of the disturbing noises is obtained by providing a gap between the interior wall of the stator and the outer wall of the bearing journal, whereby the gap is preferably filled, at least in part, with a viscous medium. Instead, or additionally, flexible, preferably

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vibration-absorbing elements may be provided, for example O-rings, for bridging the gap between coupling of stator and bearing journal. The coupling, however, must not be designed in such fashion that torque transmission may substantially be facilitated. As a result of these measures, further improved noise suppression was achieved. Although the effect of these measures have not been clarified to the last detail, one may assume that as a result of the non-torque transmitting coupling mode between stator and bearing journal, the resonance properties (resonance frequency and damping) of the rotor/bearing journal system are altered in a way so that hardly any disturbing noises are produced.

In the preferred embodiment of the invention, the torque transmission from the stator to the remaining housing takes place via a support plate, which may be designed as a punched-out grid.

The stator itself is mounted on the support plate. This results, on the one hand, in very simple installation, - on the other hand, high-frequency torque variations can be greatly damped by the flexibility and damping properties of the support plate and/or the stator/support plate system.

Vibrations of the entire housing and, possibly, any resulting excitation of the rotor/bearing journal system are hereby reduced or suppressed.

In order to avoid a mechanical overload of the support plate, particularly if same has small dimensions, means may be provided at the support plate for non-positive and/or positive torque transmission to the remaining housing, for example in form of surface roughening, denticulation or fluting on the underside of the support plate which produce, jointly with appropriate press-on pressure of the plate against the housing, an improved coupling for torque transmission. Said roughening, denticulation or fluting can be provided, for example at non plastic-coated conductor tracks of the punched-out grid realizing the support plate. In this manner simultaneous electrical contacting of the housing can occur, for example, by mass potential.

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Additional specific embodiments of the invention are apparent from the sub-claims.

In the following, the invention is explained in greater detail making use of one of the specific embodiments represented in the drawing . The drawing depicts the following:

Fig. 1. a perspective exploded representation of the basic components of an electromotively driven pump with a drive according to the invention;

Fig. 2. a central, vertical longitudinal section through the pump in Fig. 1 in fully-mounted state.

Fig. 1 depicts an electromotively driven pump 1, comprising a housing 3, an electronic selection device 5 and also a stator 7 and a rotor 9. A protective hood for covering the motor, which can be joined to the housing, is also depicted in Fig. 2. Needless to say, the invention is not limited to the represented embodiment for which the inventive drive is designed as an integral part of the pumping mechanism. Instead, such drive can be realized by itself or integrated jointly with other driven devices.

Housing 3 includes the entire pumping mechanism and has in the anterior wall an outlet aperture 11 (pressure exit) and in its rear wall a take-in aperture 13 (not shown in more detail).

Starting from the bottom of housing 3, a cylindrical wall or bearing journal 15 extends in upward direction, in which is provided the driven shaft 18 of the drive which is mounted by means of

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bearings 17, said driven shaft serving, at the same time, as drive shaft for the pumping mechanism.

Housing 3 preferably consists of aluminum- or magnesium cast metal.

The electronic selection device 5 is arranged in housing 3. It includes a plate 19, on which are provided the necessary mechanical, electrical, electro-mechanical and electronic components.

Plate 19 has a recess 21 in which engages the bearing journal 15 of housing 3. Plate 19

is designed as a combination of an extrusion-coated punched-out grid (for high current intensities) and a printed conductor plate (for low current intensities).

Motor 7 (!?) has a stator 7 with the required number of stator windings. Stator 7 likewise has an axial recess 25 by means of which stator 23 is placed on the bearing journal of housing 3. Stator 7 is firmly fastened to the plate 19, in particular to the respective punched-out grid, for example by means of soldering or welding of the winding contact connections with the conductor tracks of the punched-out grid.

The rotor 9 is constructed as external rotor and is rotationally arranged in housing 3 by means of the firmly with the rotor connected drive shaft 18 and bearing 17. Needless to say, rotor 9 is joined with the drive shaft 18 in the appropriate fashion.

The entire arrangement is covered by a protective hood, represented in Fig. 2; said protective hood is placed on the collar 27 of the lateral wall of housing 3.

In housing 3 are provided two placement areas 29 for power semi-conductors 31 of the electronic selection device 5. These power semi-conductors may involve, for example, Power-FET's. The power FET's normally have relatively small cooling bodies 31a, which generally, however, cannot guarantee adequate transport of leakage heat.

To that end, the small cooling bodies 31a are placed on the placement areas 29 in housing 3 and are brought into adequate heat conducting contact with same via suitable means.

Since the cooling bodies 31a of the power semi-conductors 31 fulfill, at the same time, also the function of an electrical contact, there may be provided, if necessary, between the rear side of the small cooling bodies 31a and the placement areas 29 an electrically isolating, but adequately heat conductive layer. If appropriate, however, a direct electrical contact between the cooling bodies 31a and housing 3 may also be established, should this be electrically permitted or desired.

In the particular represented embodiment, two each power semi-conductors 31 are attached to the placement surfaces 29 by means of elastic clamps 33.

The regions of housing 3 below the placement surfaces 29 preferably have one or several channels through which flows the medium to be transported by the pump. The corresponding regions thus act like heat exchangers. Needless to say, to that end, measures known by themselves can also be provided for improving the transport of heat from the power semi-conductors 31,

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such as, for example, the provision of an area as large as possible for the medium to be transported in the regions below the placement regions 29. A multitude of channels may, for example, be provided to that end, or one or several channels may have interior cooling fins.

In order to avoid noises which develop with the standard drives and which occur in actual practice, caused by relatively high-frequency variations of the generated torque moment, the inventive stator 7 is not joined directly to the bearing journal in non-positive fashion. Instead, the bearing journal 15 and the stator 7 are dimensioned in such way that a gap is formed between the inner wall of the stator and the outer wall of the bearing journal. The axial split pin provided in known motors for non-positive and positive coupling of stator 7 and bearing journal, which engages in corresponding grooves in the inner wall of the stator and outer wall of the bearing journal, is eliminated in the construction according to the invention. Said split pin would create a rigid coupling of the rotor masses with the mass of the remaining drive, as a result of which the resonant frequency of the totality of the stator/bearing journal system would again come within the range of the high-frequency torque variations occurring over the entire operating range. Said stator/bearing journal system would then again be incited to produce the disturbing, noise-producing vibrations.

In order to nevertheless attain adequate fixation of the stator 7, one or several O-rings 12 (as depicted in Fig. 2) may be provided in grooves 12a in the outer wall of the bearing journal 15.

These O-rings must be sufficiently flexible so that no unwelcome rigid coupling is created between stator 7 and bearing journal 15. Thus, the O-rings in their flexibility and damping property serve the function of vibration-damping coupling elements between stator and bearing journal.

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Instead of the O-rings 12 or in addition to these O-rings, the gap may also be filled (partially) with a viscous medium, for example fat. This also avoids or further reduces rigid coupling.

At any rate, a substantially rigid coupling between stator 7 and bearing journal 15 is to be avoided, which would entail a tangential power transmission or the transmission of the torque from the stator to the bearing journal.

According to the invention, the torque moment is not transmitted from the stator 7 via the bearing journal 15, but directly to the housing 3 or the bottom of the housing. The bearing journal 15, aside from the mounting of the rotor shaft 18, serves only for axial control or fixation of the stator.

According to the embodiment of the invention represented in the drawing, the stator is firmly joined with the support plate, realized in the form of plate 19. As mentioned previously, this can be done by means of soldering or welding of connection contacts to the conductor tracts of the punched-out grid representing plate 19.

Since plate 19 is firmly mounted, together with the thereon attached stator 7, in housing 3, the torque moment transmission from the stator to the housing can take place via plate 19. This produces the additional benefit that the plate, with its practically always existing flexibility, serves for damping the high-frequency variations of the torque moment to be transmitted. This applies in particular with respect to the design (at least in part) of plate 19 as extrusion plastic-coated punched-out grid.

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The vibration-damping properties of plate 19 come particularly to light when the plate is not rigidly connected, over the entire area, with housing 3, but only in partial areas, or in spots, for example by attaching the plate to the housing by means of screws.

In order to ensure safe transmission of torque moment and to avoid a mechanical overload or destruction of the plate, same must either be appropriately dimensioned or additional measures must be taken to promote transmission of torque. To that end, preferably in the attachment region of the stator, means may be provided on the plate for positive and/or non-positive coupling with the housing. Said means can be realized, for example, in form of surface roughening or denticulation on the underside of the plate, which assure, concurrently with press-on forces operating in these regions, an improved torque moment transmission to the housing. Said roughening or denticulation can preferably be provided on non-plastic coated conductor tracts, which may, at the same time, serve for establishing electrical contact with the housing.

Needless to say, extensions extending in downward direction may also be provided for said purpose at the underside of the plate, which cooperate with stops provided in the housing for the transmission of the torque moment.

All in all, as a result of the inventive construction, disturbing noise-producing vibrations of the stator/bearing journal system are avoided in that the bearing journal merely serves for axial and transverse fixation of the stator and that transmission of the torque moment is assured by twist-proof installation of the stator in the housing, preferably by means of a support plate.

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